A Description of the HFIP Corrected Consensus Approach (HCCA)

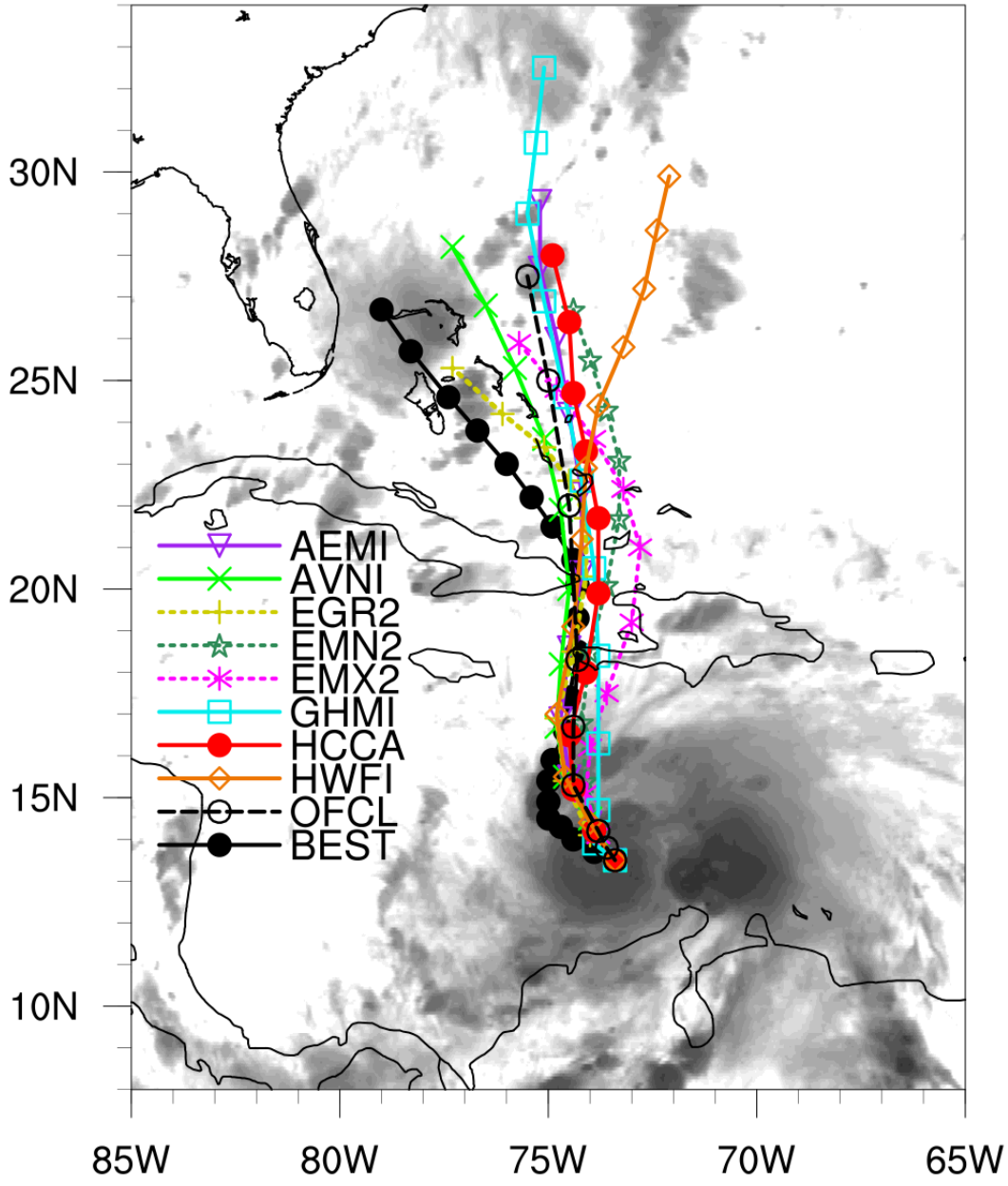
HFIP Annual Meeting, Miami, FL
January 11-12, 2017

Anu Simon[1,3] and Andrew Penny[2,3]
[1]Cyberdata Technologies, Inc.
[2]Systems Research Group, Inc.
[3]National Hurricane Center

Acknowledgements:
Mark DeMaria, James Franklin, Richard Pasch,
Edward Rappaport, and David Zelinsky

Outline

1. Methodology
2. Real-time 2015 HCCA forecasts and verification
3. Input model sensitivity experiments
4. Rapid Intensification
5. Preliminary 2016 verification
6. Conclusions and future work



At a particular forecast hour, t, $HCCA_t$ for latitude/longitude/intensity is computed as:

$$HCCA_t = HCCA_{t-1} + \sum_{i=1}^{N} a_i \left[\left(F_{i_t} - F_{i_{t-1}} \right) - \frac{1}{K} \sum_{k=1}^{K} \left(T_{i,k_t} - T_{i,k_{t-1}} \right) \right] + \frac{1}{K} \sum_{k=1}^{K} \left(O_{k_t} - O_{k_{t-1}} \right)$$

- $HCCA_{t-1}$ *is the previous 12-h HCCA forecast value*
- $\left(F_{i_t} - F_{i_{t-1}} \right)$ is the current forecast increment value for model i
- $\frac{1}{K}\sum_{k=1}^{K}\left(T_{i,k_t} - T_{i,k_{t-1}} \right)$ is the mean increment value for model i from a set of K training set forecasts
- $\frac{1}{K}\sum_{k=1}^{K}\left(O_{k_t} - O_{k_{t-1}} \right)$ is the mean increment of the verifying analysis
- N *is the number of input models and* a_i is the weighting coefficient for model i

- The weighting coefficients are chosen to minimize the sum of the squared error over K training forecasts.
- Coefficients can be positive or negative and are not constrained to add up to one.
- The best performing models generally receive the largest weights, and negative coefficients don't necessarily indicate that a particular model is inferior to the other input models.

References:

Williford, C. E., T. N. Krishnamurti, R. C. Torres, S. Cocke, Z. Christidis, and T. S. V. Kumar, 2003: Real-time multimodel superensemble forecasts of Atlantic tropical systems of 1999. *Mon. Wea. Rev.*, **131**, 1878–1894. doi:http://dx.doi.org/10.1175//2571.1

Krishnamurti, T. N., C. M. Kishtawal, T. LaRow, D. Bachiochi, Z. Zhang, C. E. Williford, S. Gadgil, and S. Surendran, 1999: Improved weather and seasonal climate forecasts from multi-model superensemble. *Science*, 285(5433), 1548–1550. doi: 10.1126/science.285.5433.1548

Training Phase

- Separate training sets are used for the Atlantic and East Pacific basins
- Whenever possible forecasts from the most current model configurations are used in the training set.
- The training set is updated after a storm dissipates and no other storms are present in a particular basin

Forecast Phase

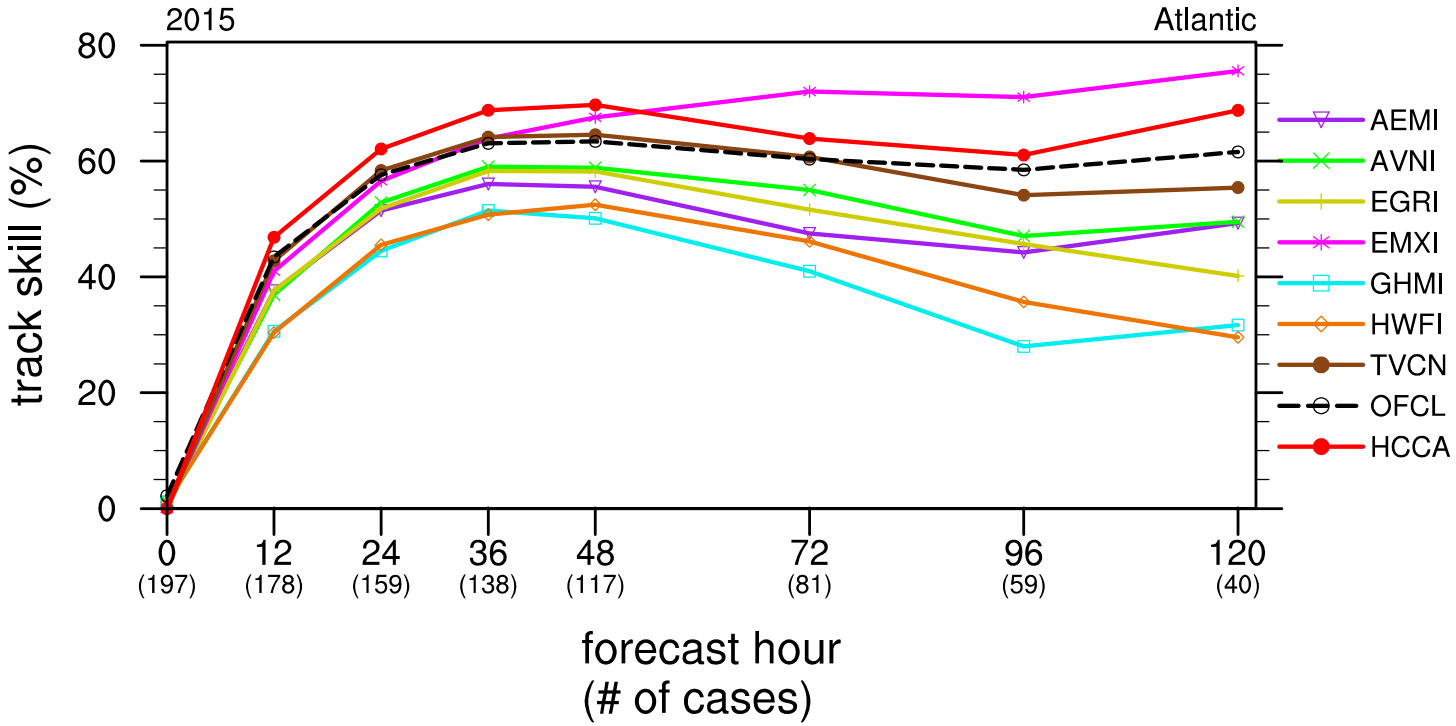
- A forecast-specific training set is created “on-the-fly” based on forecast model availability for a particular forecast hour in real-time.
- If the 6-h interpolated model (e.g., AVNI) is not present, the 12-h interpolated model (e.g., AVN2) is used.
- A minimum of 3 input models are needed to compute a HCCA track and intensity forecast
- HCCA forecast is generated for systems including those below tropical storm (TS) strength, including “invests”.

2015 Track Skill

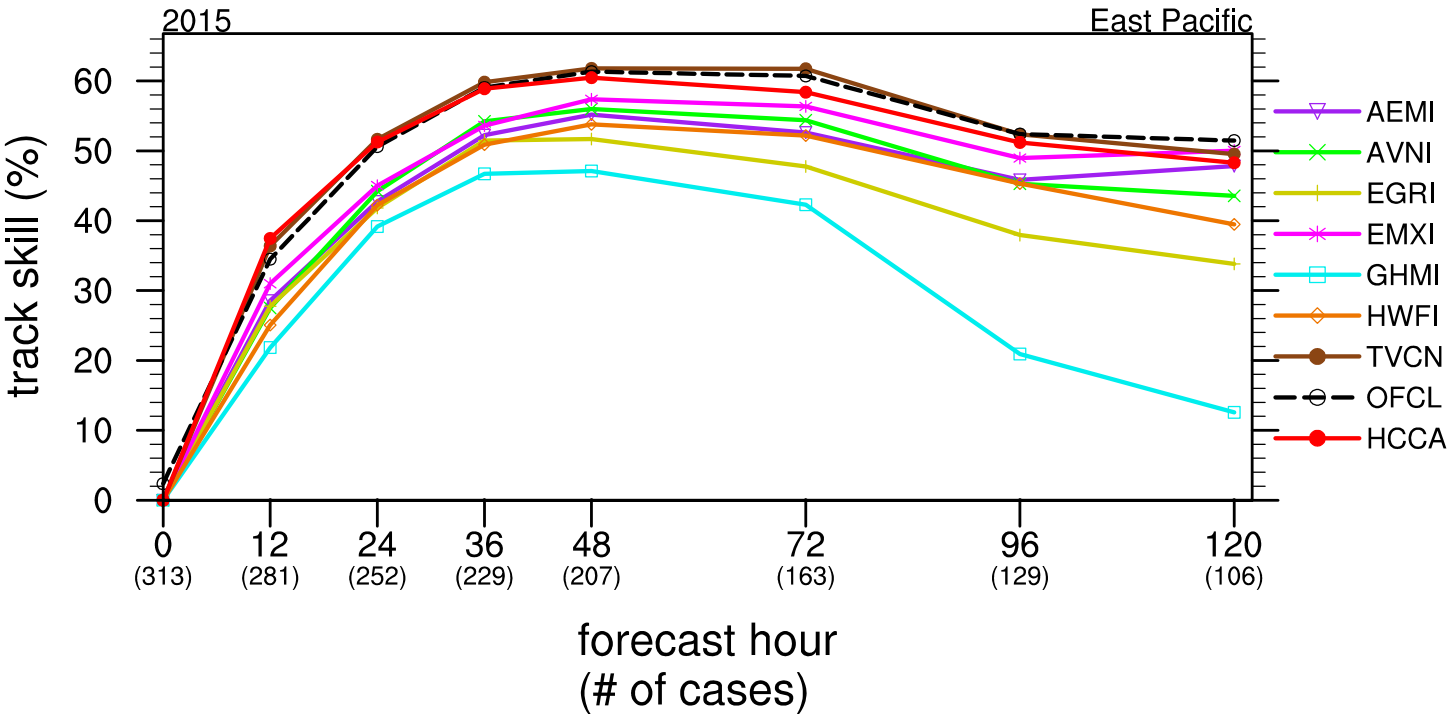
Atlantic

Track:

AEMI/2 AVNI/2
HWFI/2 GHMI/2
EMXI/2 EGRI/2

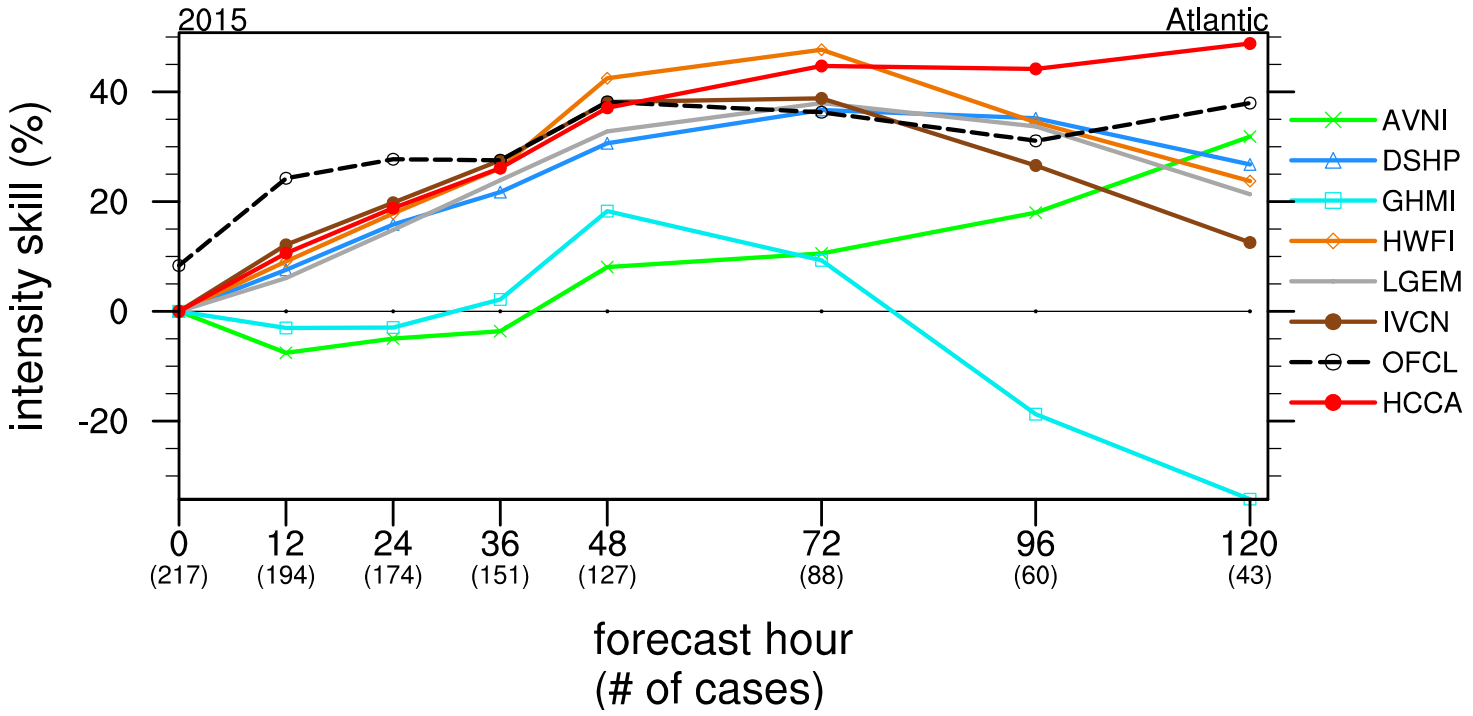


East Pacific



2015 Intensity Skill

Atlantic



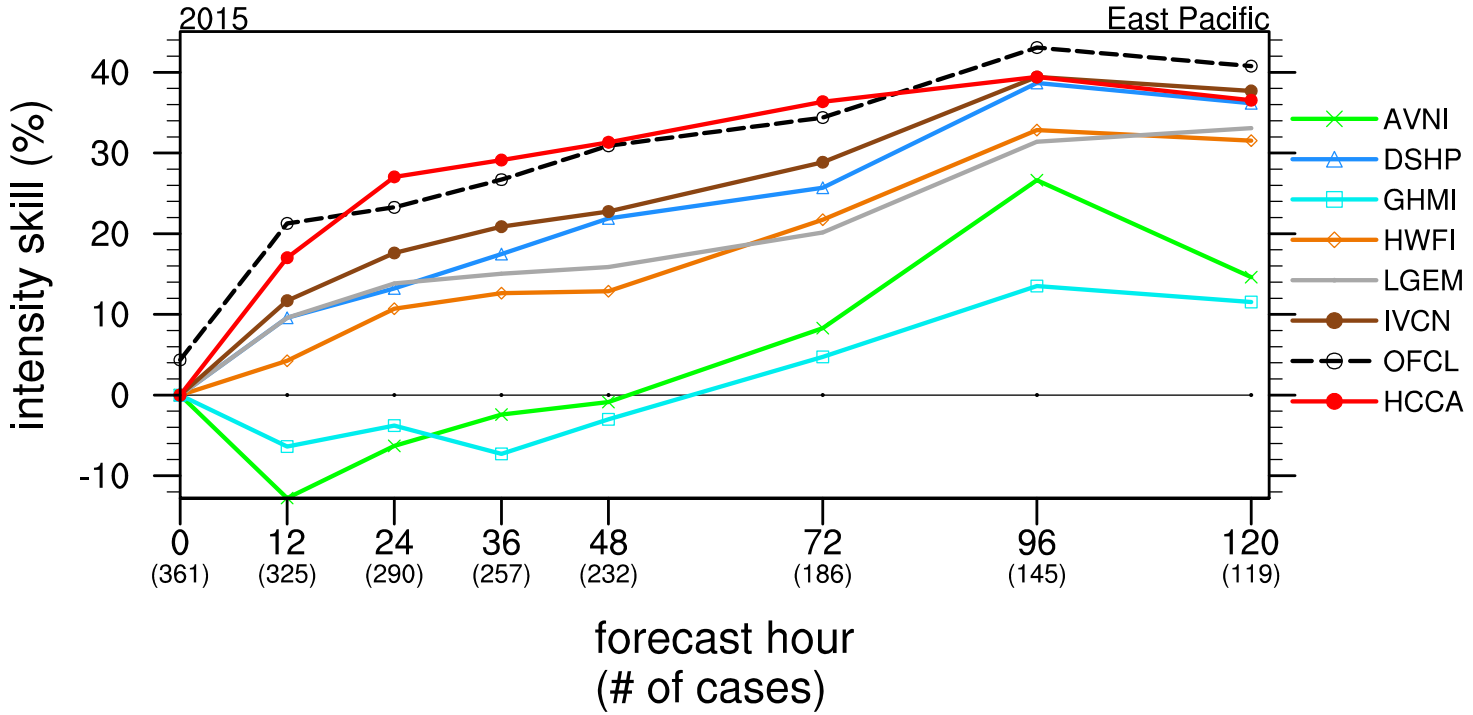
Intensity:

AVNI/2 HWFI/2

GHMI/2 LGEM

DSHP

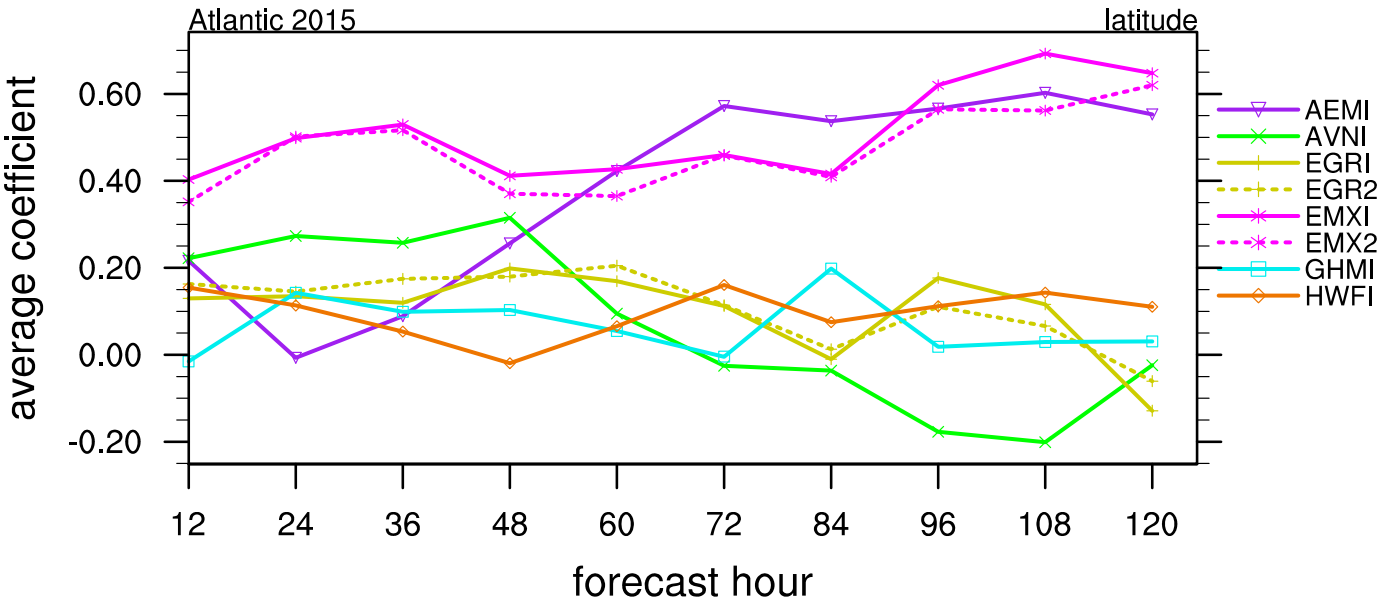
East Pacific



average input model coefficients

2015 HCCA latitude forecasts

Atlantic



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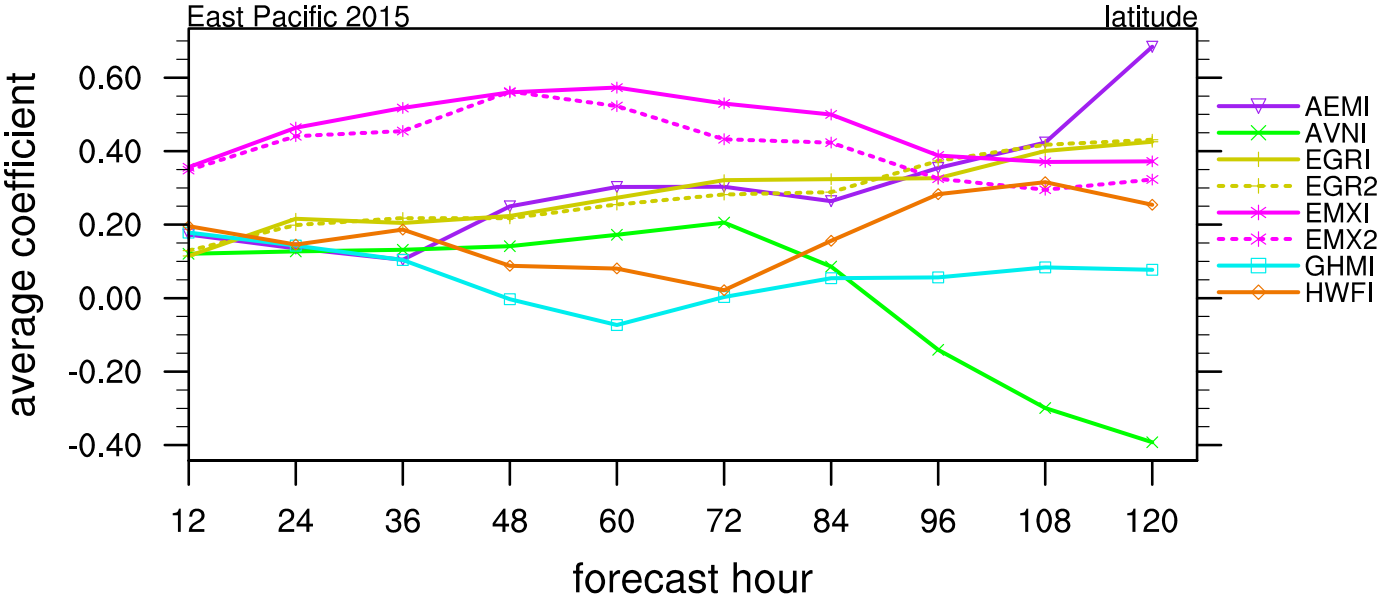
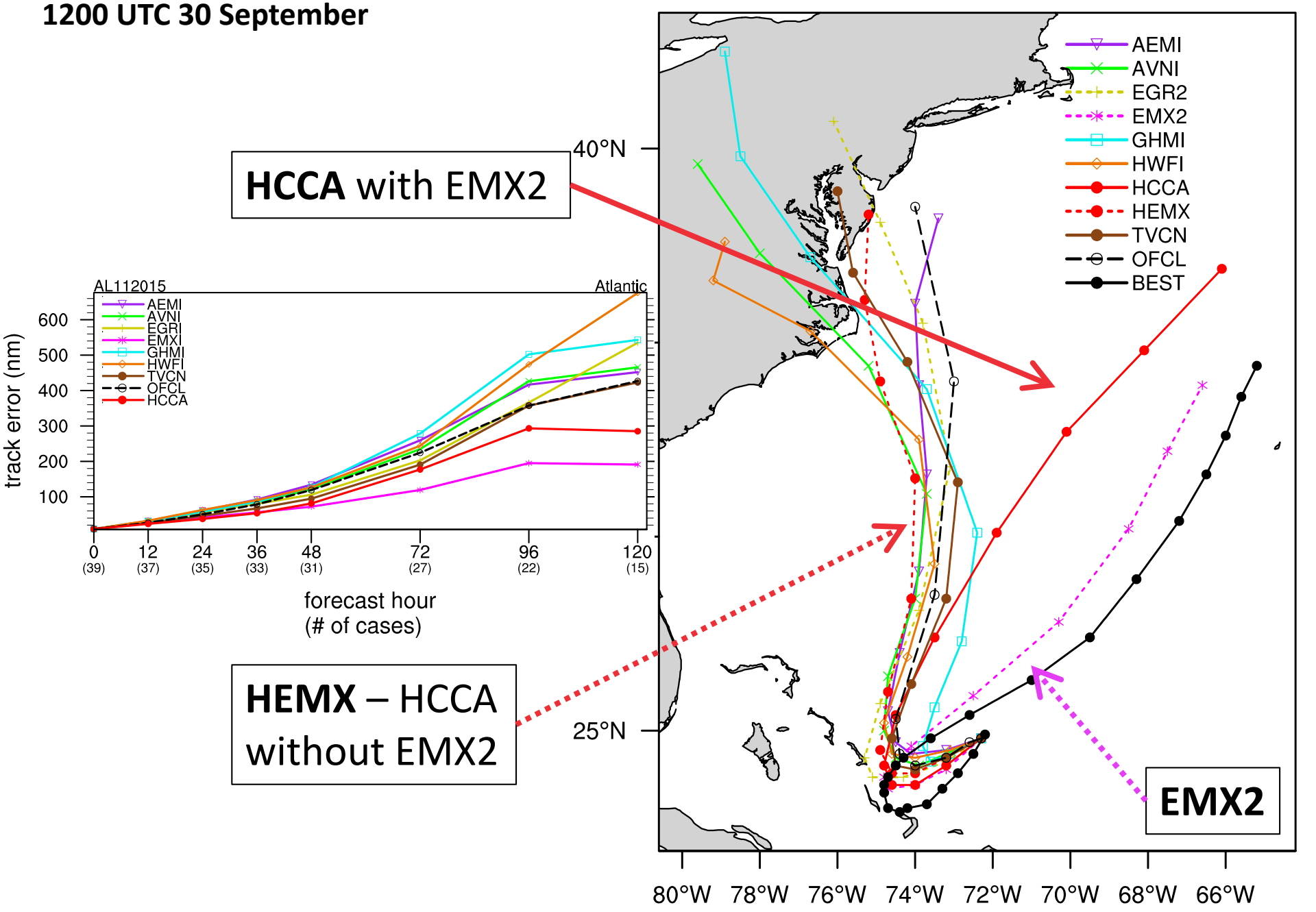


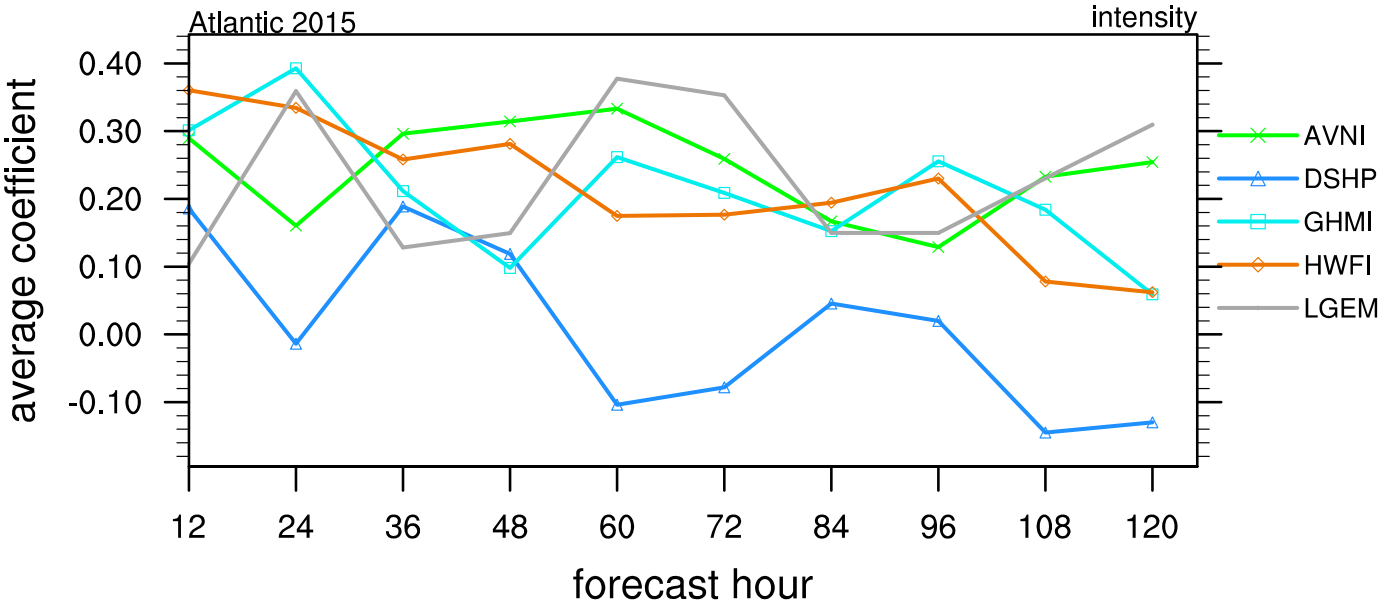
Hurricane Joaquin
1200 UTC 30 September



average input model coefficients

2015 HCCA intensity forecasts

Atlantic



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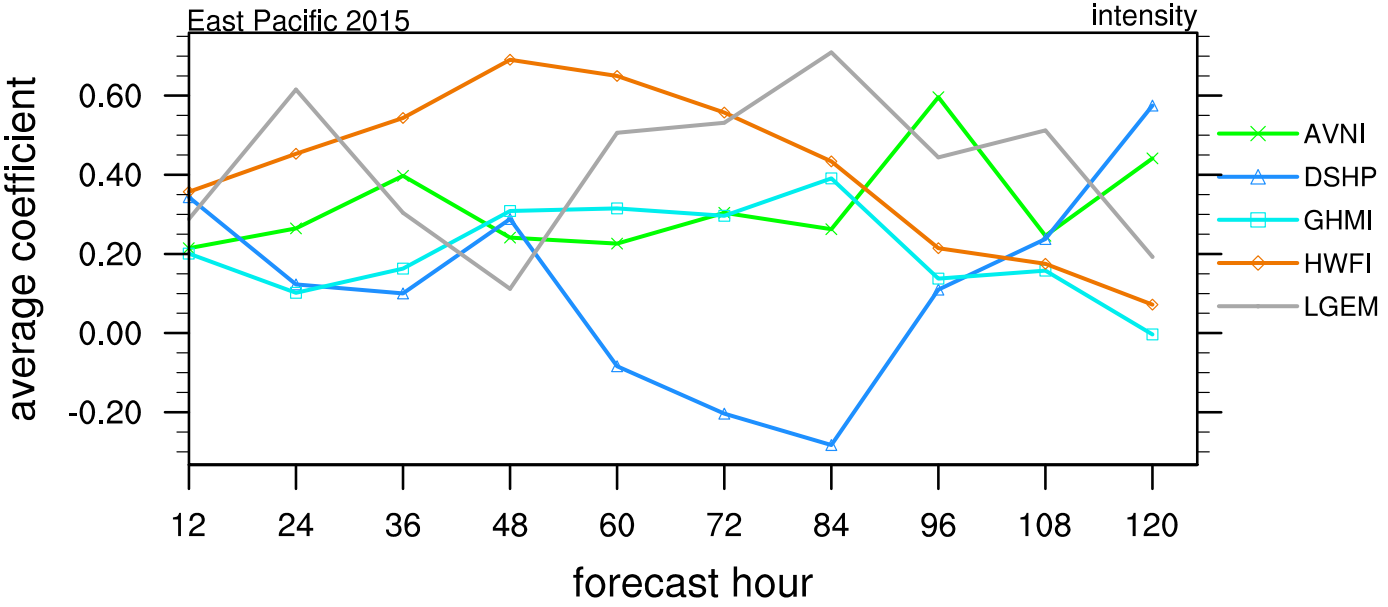
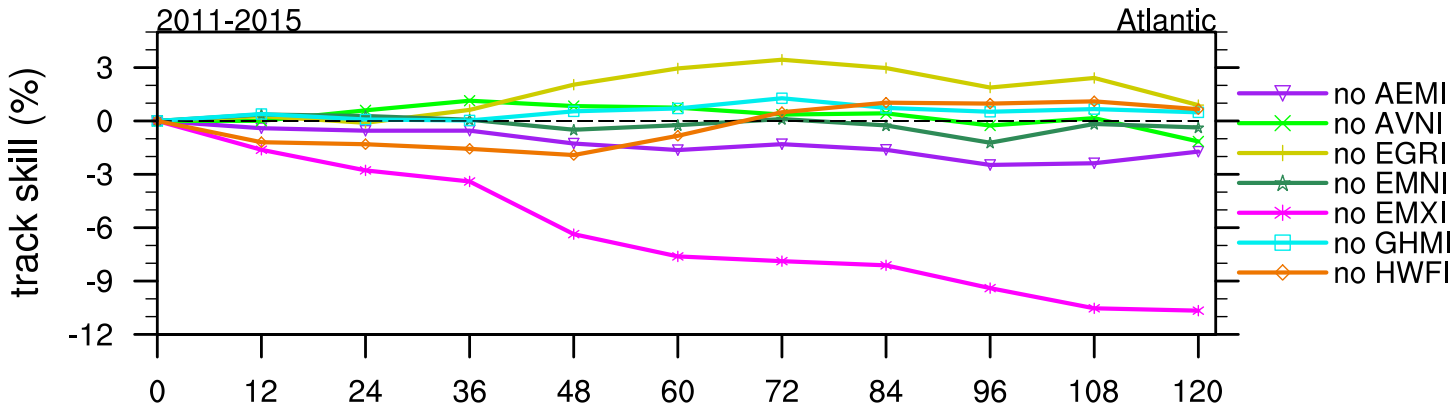


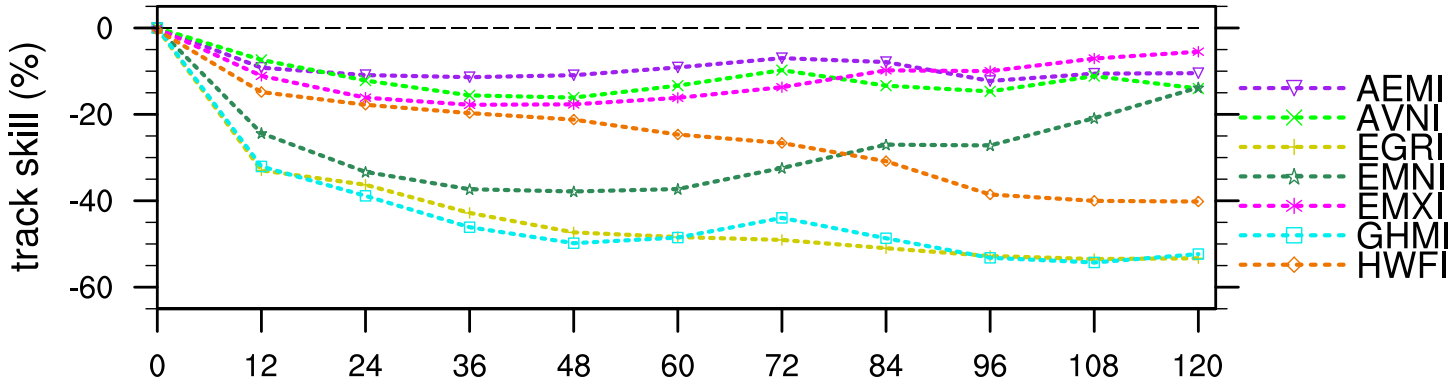
Atlantic 2011-2015
Track Skill

HCCA input model sensitivity experiments

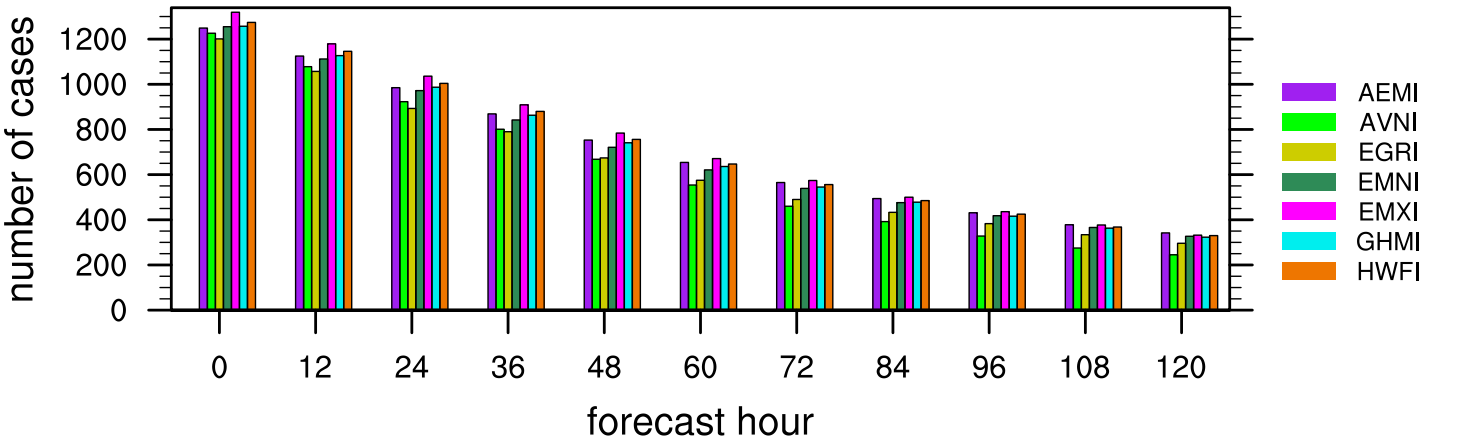
HCCA skill when excluding individual input models



individual input model skill



number input model forecasts



East Pacific 2011-2015
Track Skill

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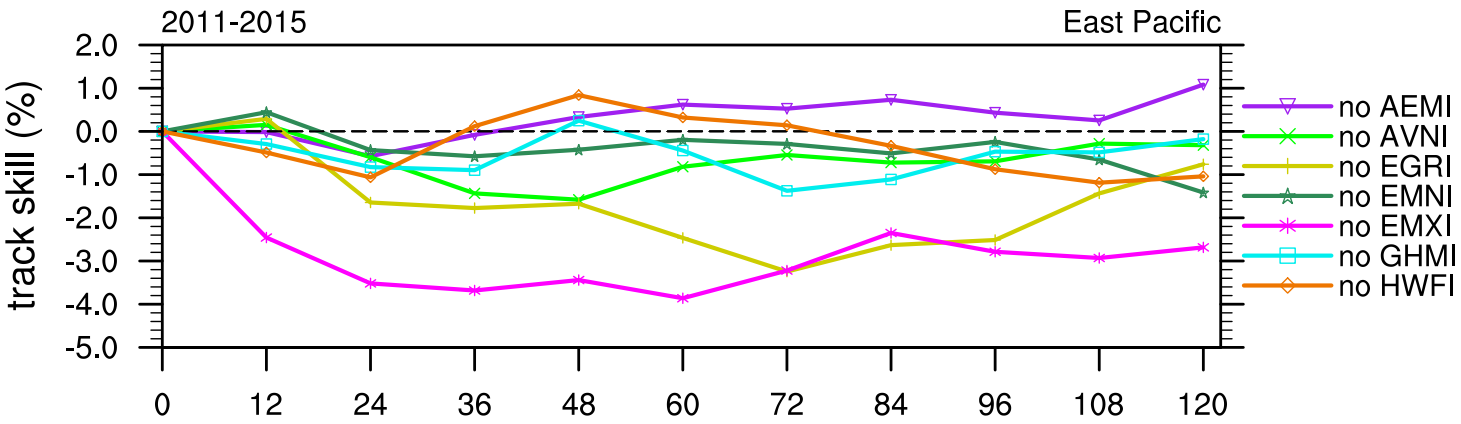
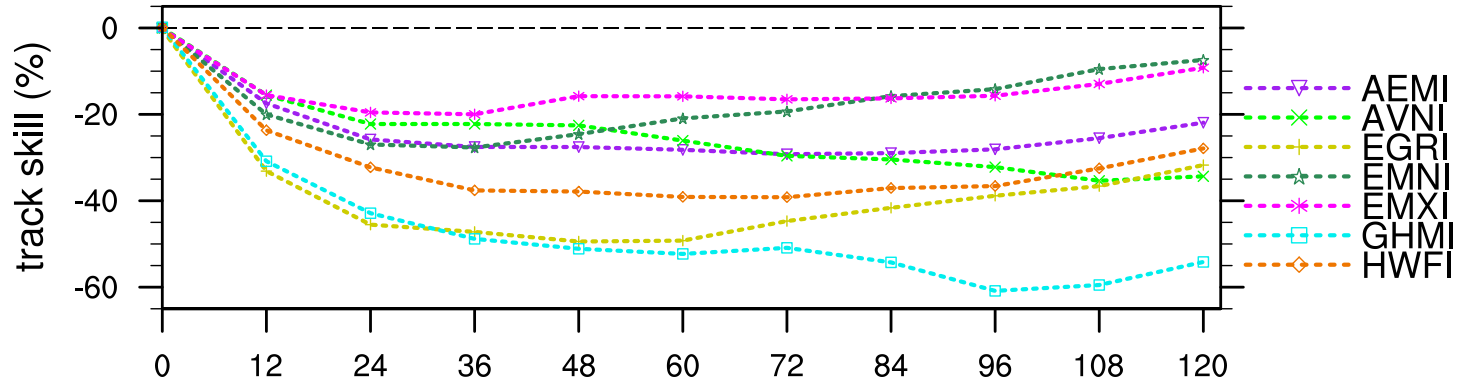
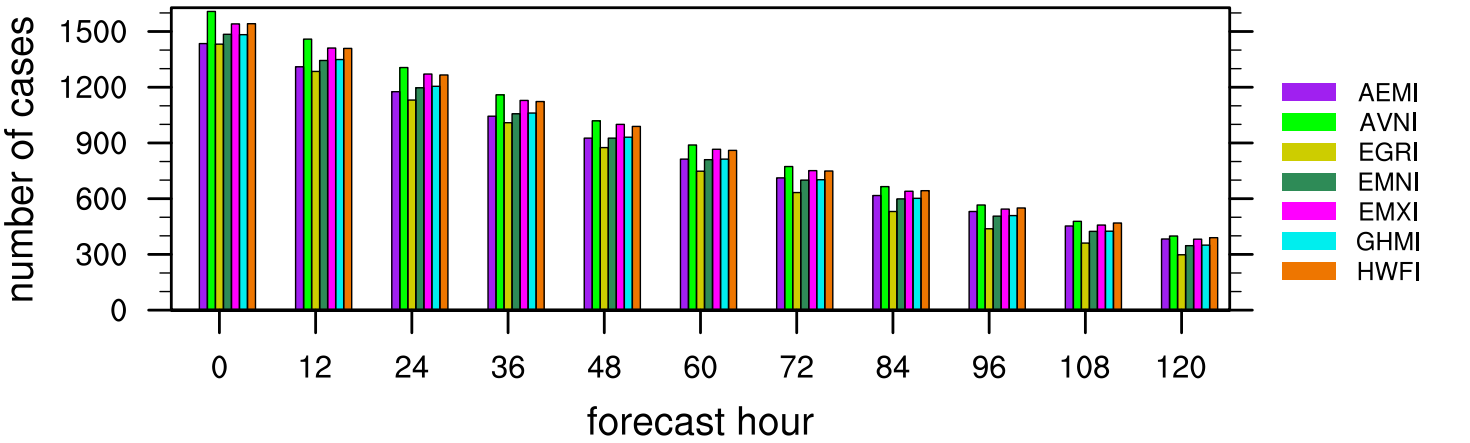


individual input model skill



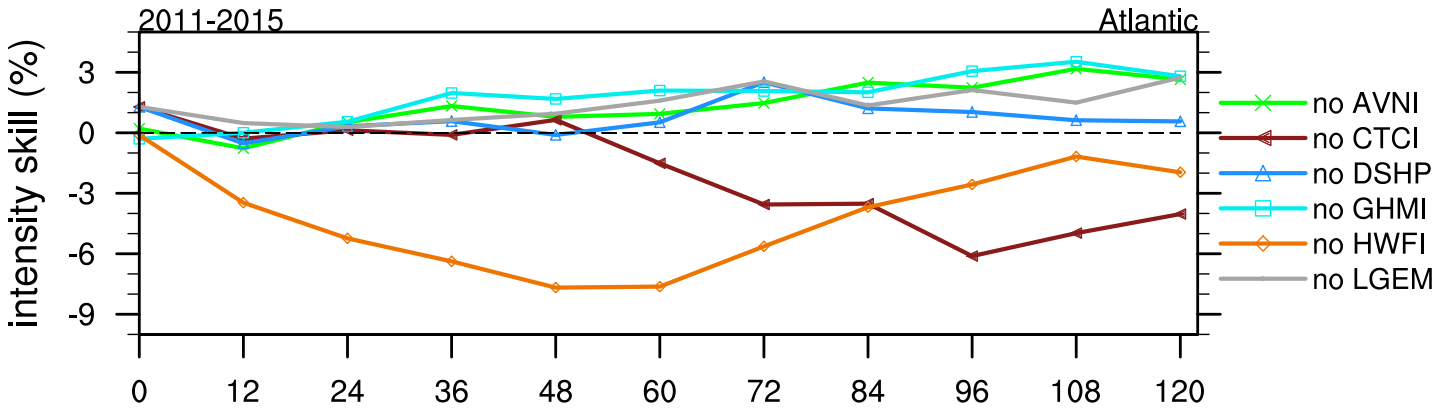
number input model forecasts



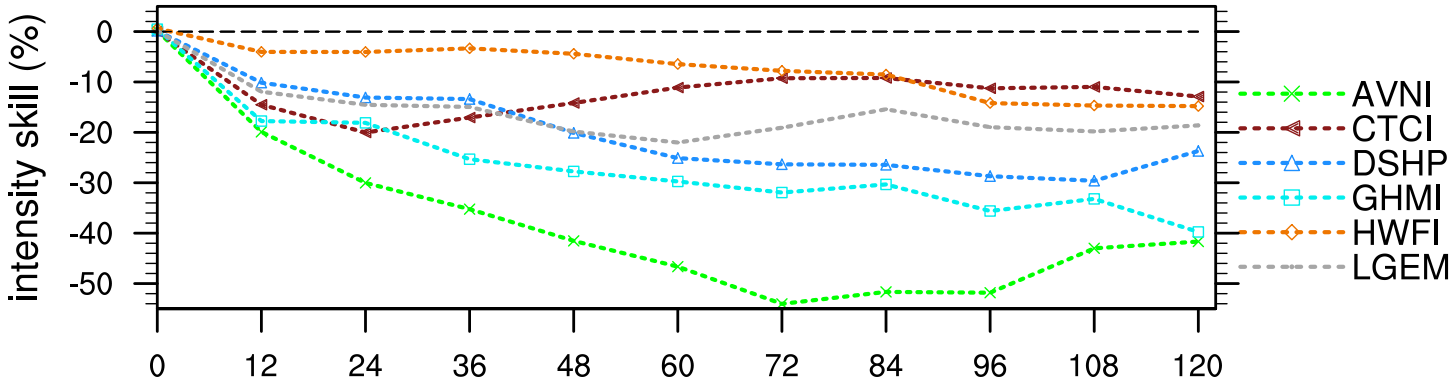
Atlantic 2011-2015
Intensity Skill

HCCA input model sensitivity experiments

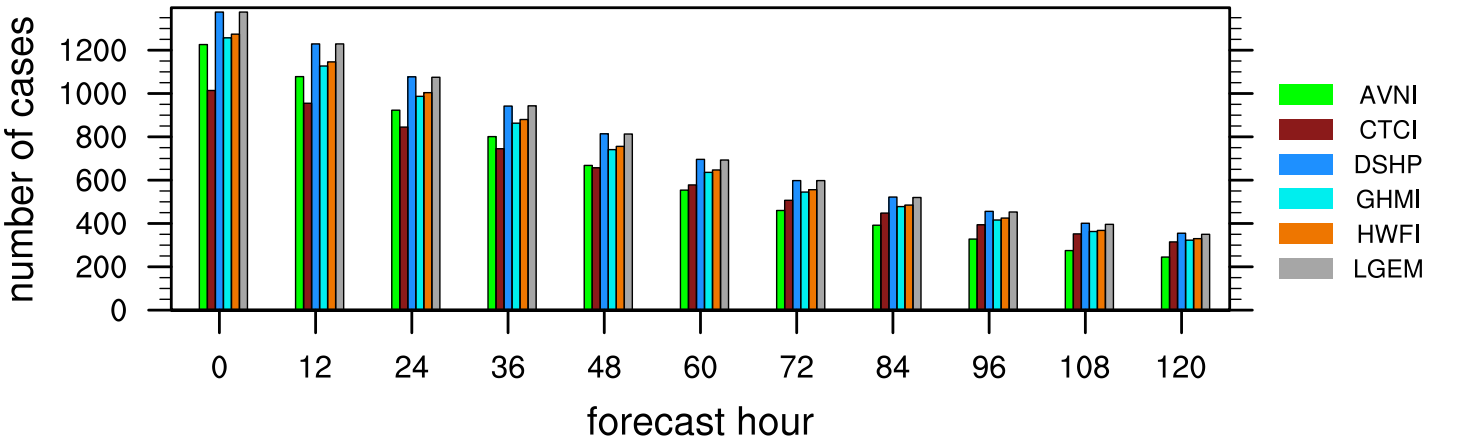
HCCA skill when excluding individual input models



individual input model skill



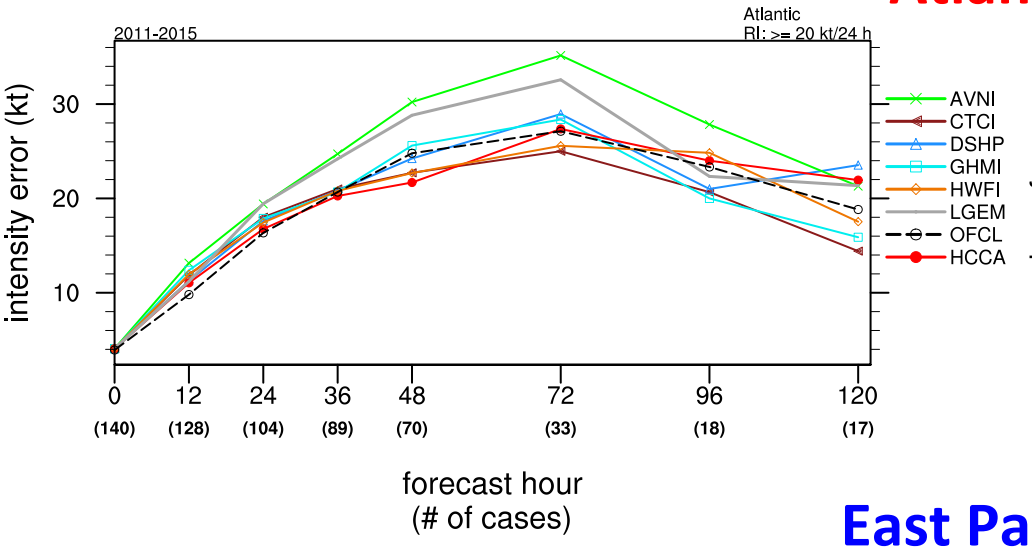
number input model forecasts



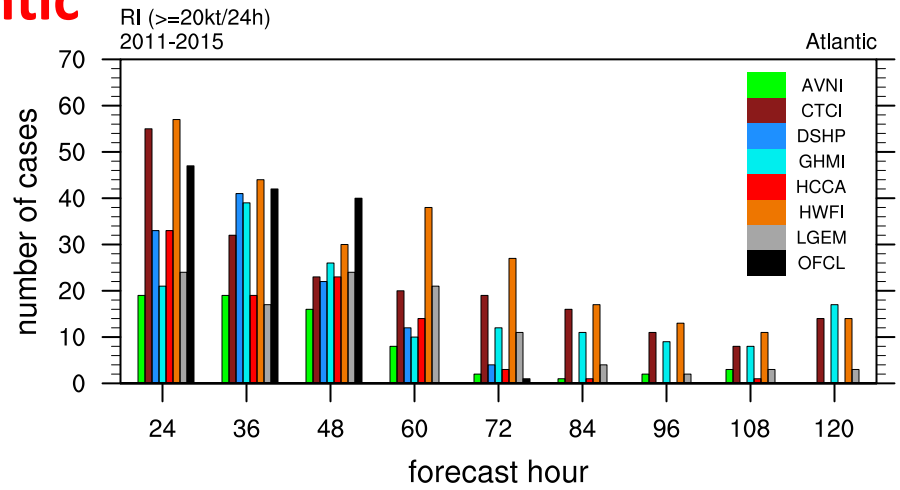
Rapid Intensification >= 20 kt / 24 h
2011-2015

Intensity Error

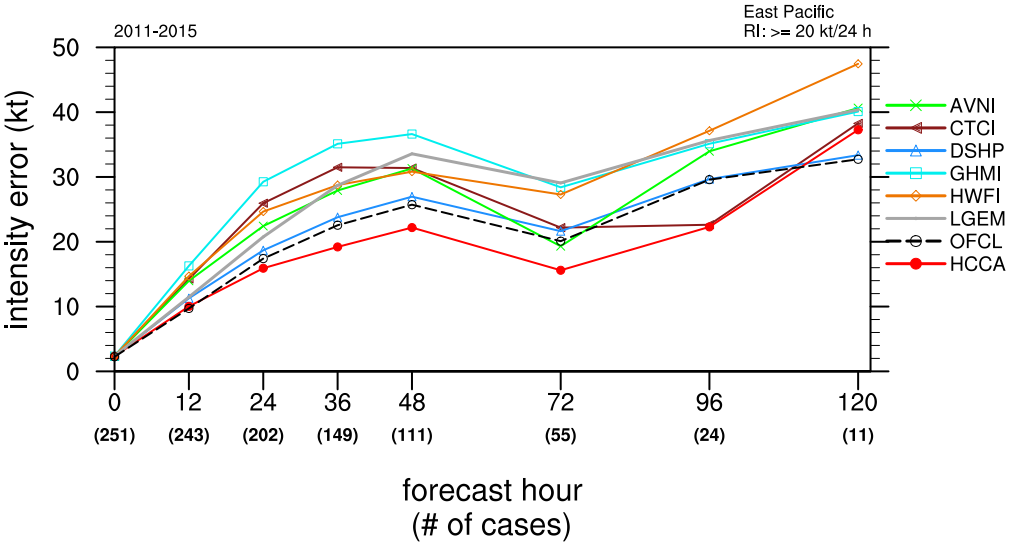
Atlantic

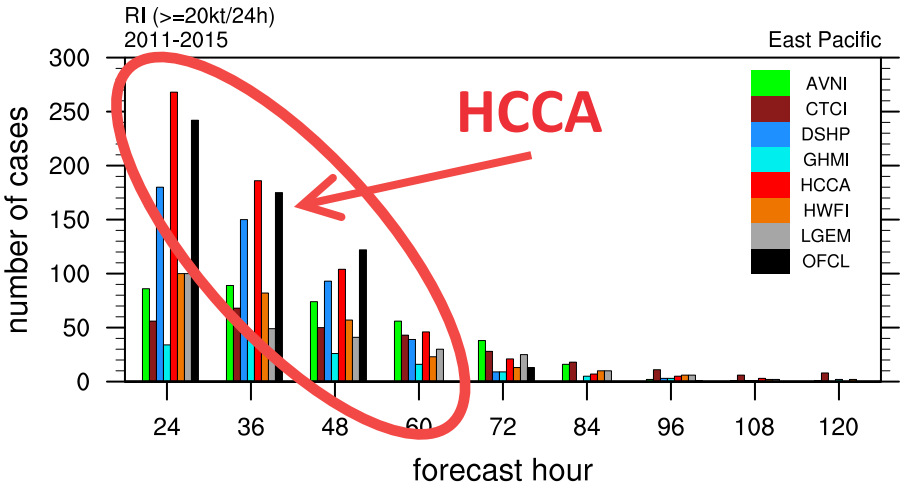


Forecast Count



East Pacific



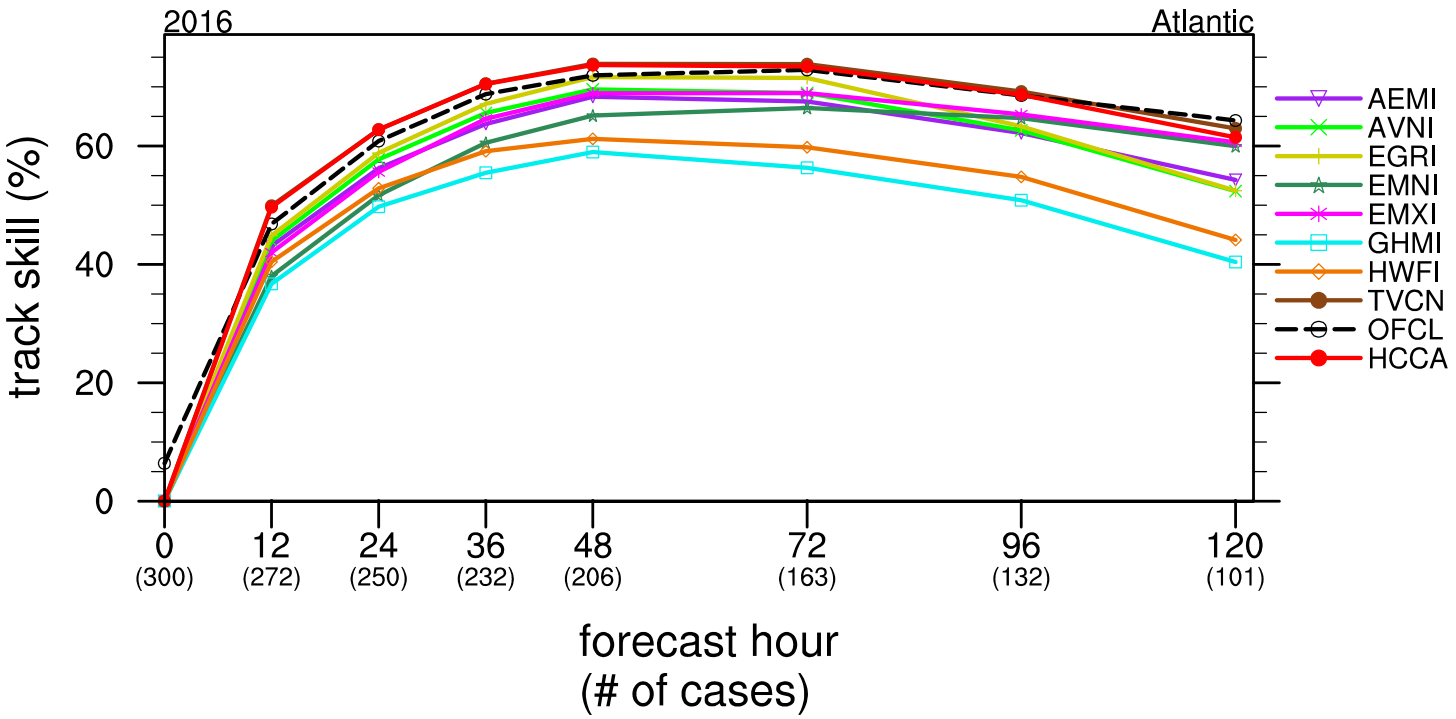


2016 Track Skill

Atlantic

Track:

AEMI/2 AVNI/2
HWFI/2 GHMI/2
EMXI/2 EGRI/2
EMN2/3



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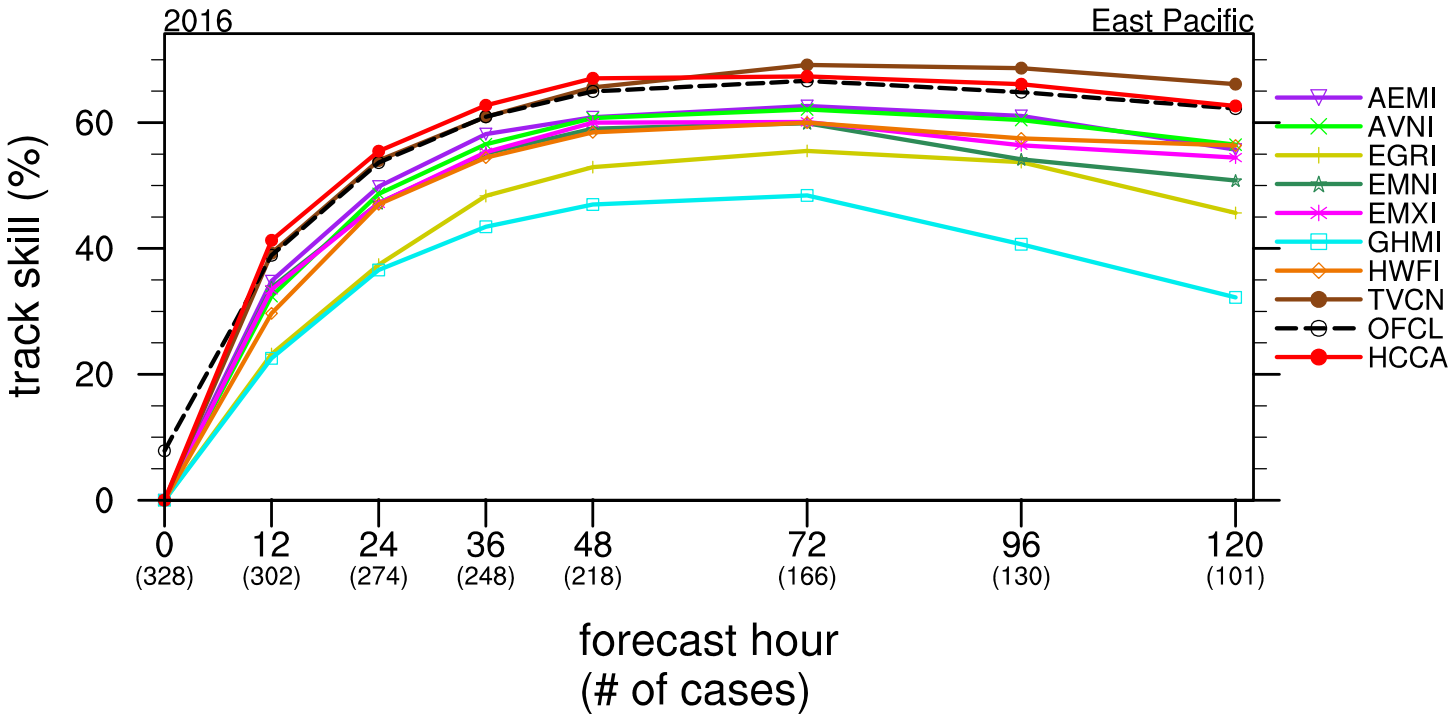


2016 Intensity Skill

Atlantic

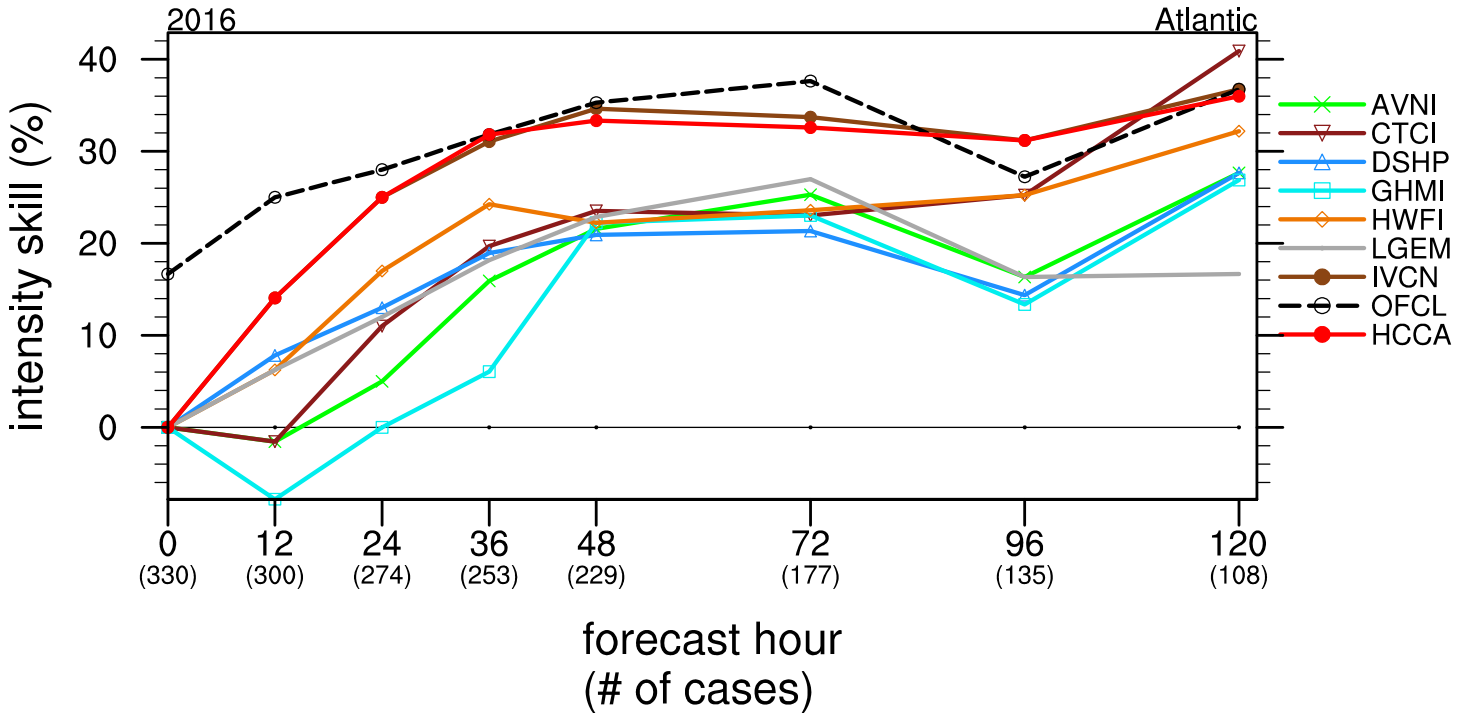
Intensity:

AVNI/2 HWFI/2

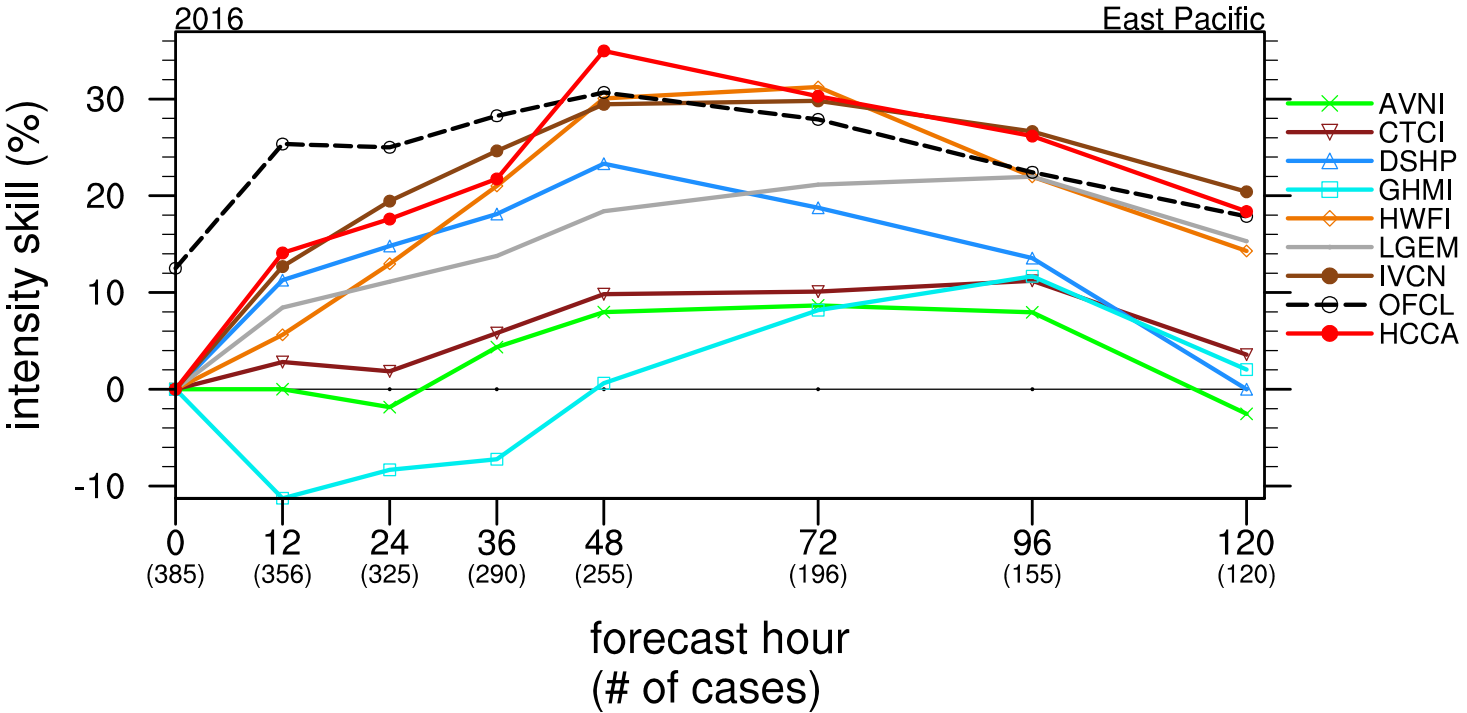
GHMI/2 LGEM

DSHP

CTCI/2



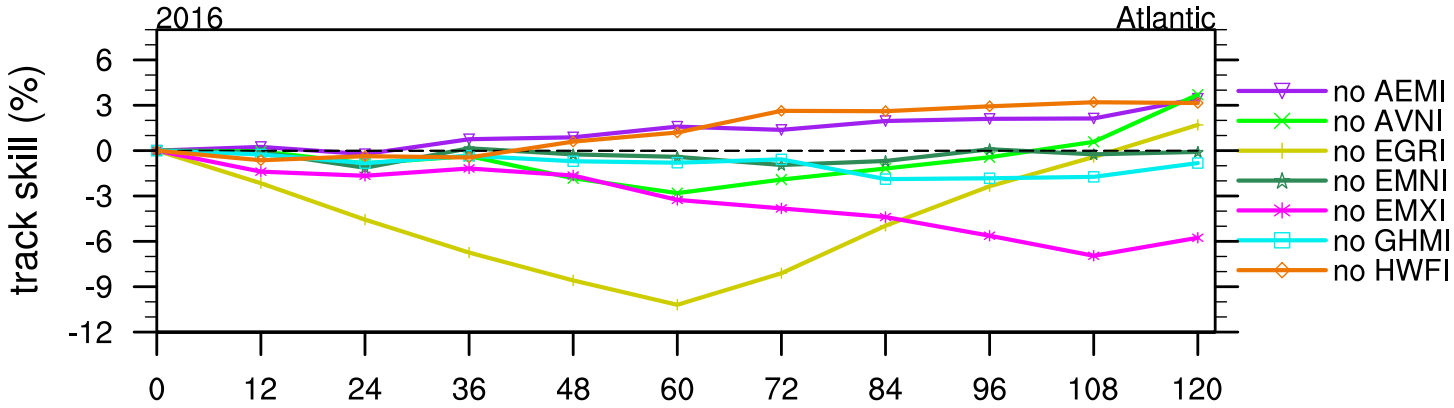
East Pacific



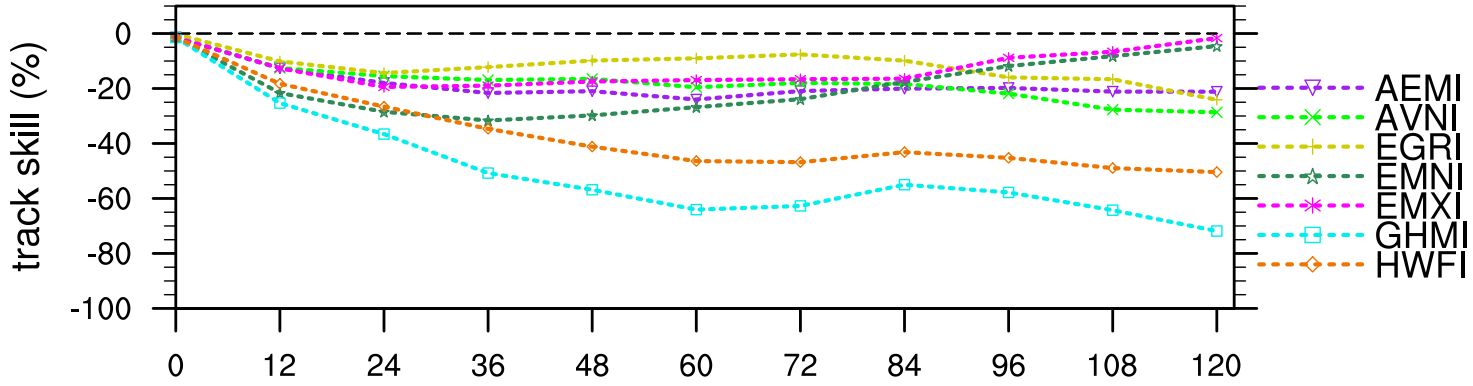
Atlantic 2016 Track Skill

HCCA input model sensitivity experiments

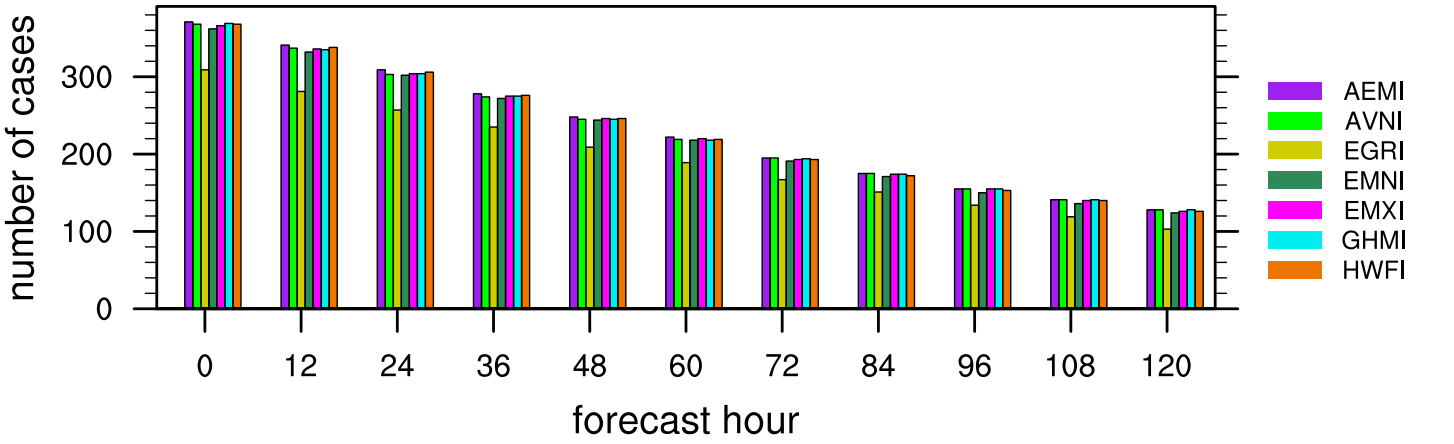
HCCA skill when excluding individual input models



individual input model skill



number input model forecasts



Conclusions

- HCCA is an “in-house” corrected consensus technique at NHC that applies unequal weighting coefficients to input model forecasts based on a set of training forecasts

- HCCA provided skillful track and intensity guidance for the 2015 and 2016 seasons:
  - 2015: most skillful Atlantic track forecasts from 12 h to 48; most skillful eastern North Pacific intensity forecasts from 24 h to 72 h
  - 2016: most skillful eastern North Pacific track forecasts from 12 h to 48 h

- the largest coefficients for track forecasts are generally assigned to EMXI/2 and AEMI; the intensity coefficients are more varied in magnitude

- input model sensitivity experiments reveal EMXI is the most important input model for HCCA track forecasts and that HWFI and CTCI are the most important for HCCA intensity forecasts

- compared to the input model guidance, HCCA performs well for rapid intensification, especially for eastern North Pacific events; HCCA forecasts rapid intensification in the eastern North Pacific more frequently than other input models (and OFCL) at 24 h and 36 h

Future Work

- test the impact of additional input models (e.g., GFDL → HNMMB)
- evaluate techniques to stratify and match training forecasts based on the current forecast characteristics